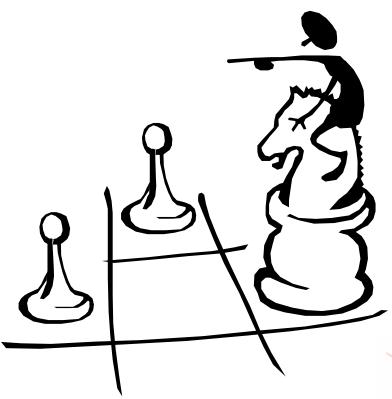


## A Systems Engineering Approach to Risk Management



Becky Reed, President, Reed Integration Inc. Steve Waddell, VP Strategy, Reed Integration Inc. REED INTEGRATION, INC.

"Almost invariably, when a program gets in trouble, the analysis of what went wrong includes inadequate or non-existent Systems Engineering."

# Multiple Options Exist For Risk Management

- NASA / SEI CRM Process
- PMI Risk Management Process
- Insurance Industry
- Medical Industry
- DoD
- Internally developed processes



#### Risk Management Failures

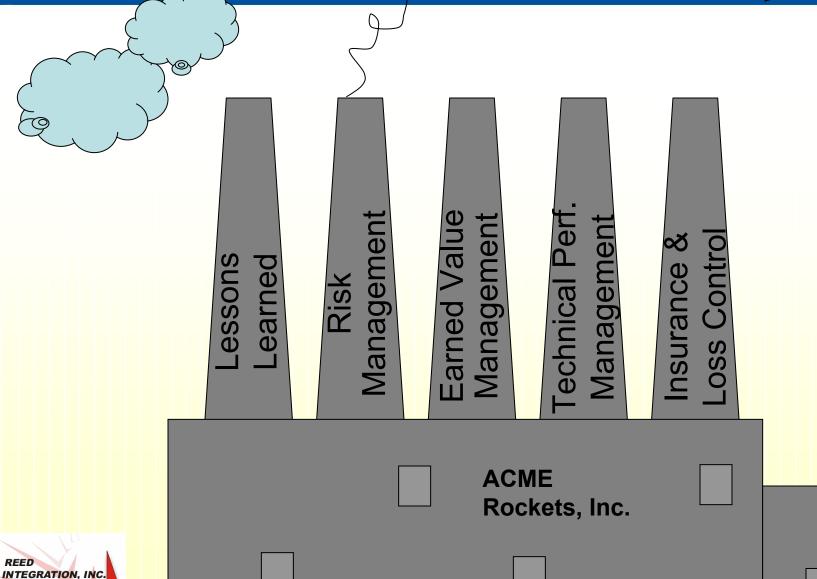
- Lack of integrated approach
  - Implementations do not reflect reality of project activities
  - Insufficient data for decision making
- Overwhelming bureaucracy
- Cultural barriers
  - Lack of support from key stakeholders
- All-consuming process complexity



Results in reactive crisis management, cost and schedule overruns, and ultimately damages the credibility of the process

### Risk Management Failures





# **Applying SE to the Risk Management Process**

- Supports overall integration
- Reduces complexity
- Establishes structure in initial phases
  - Improved likelihood for success and, therefore buy-in
  - More cost-effective, less rework
  - Transferable, repeatable process



#### The Approach

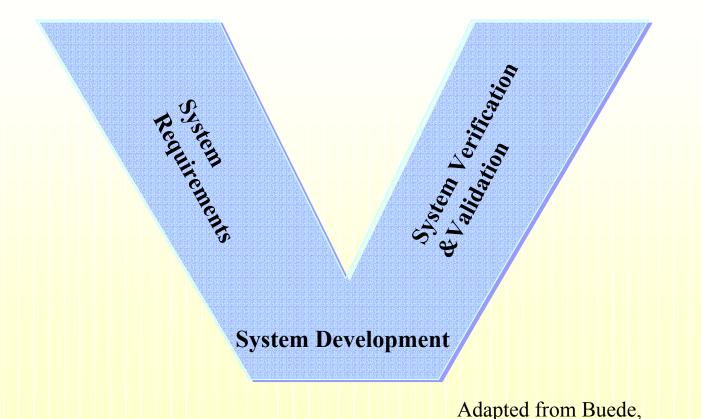
# Basic SE methods can be applied to the Risk Management Process:

- Structure the process
  - Develop your risk management system by following the SE approach
- Implement the methods
  - Requirements management
  - Interface definition and control
  - Verification / Validation
- Utilize the tools
  - Plans
  - Studies
  - Analyses



#### Introduction

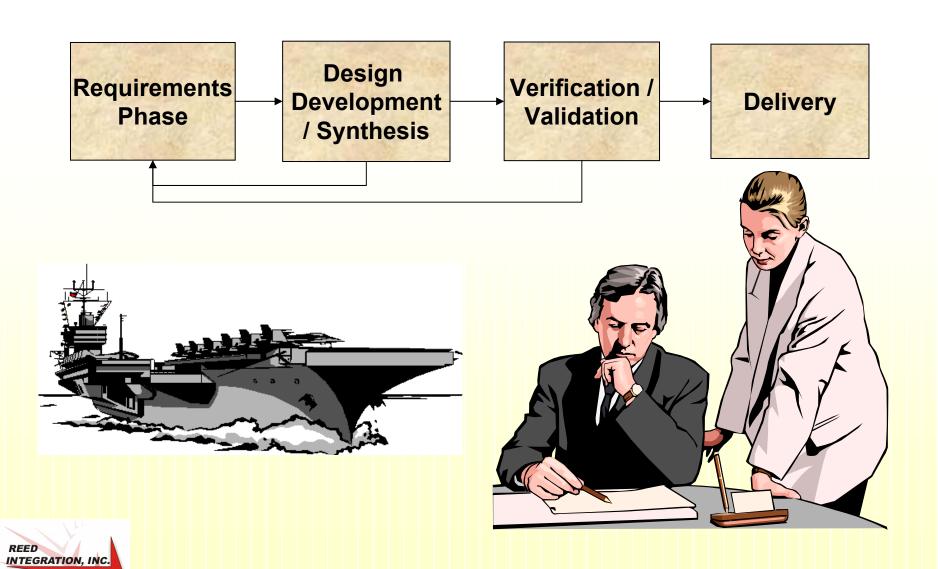
- Simplified SE Process
- The Systems Engineering "V"





Adapted from Buede,
The Engineering Design Of Systems

## SE and The Project Life Cycle



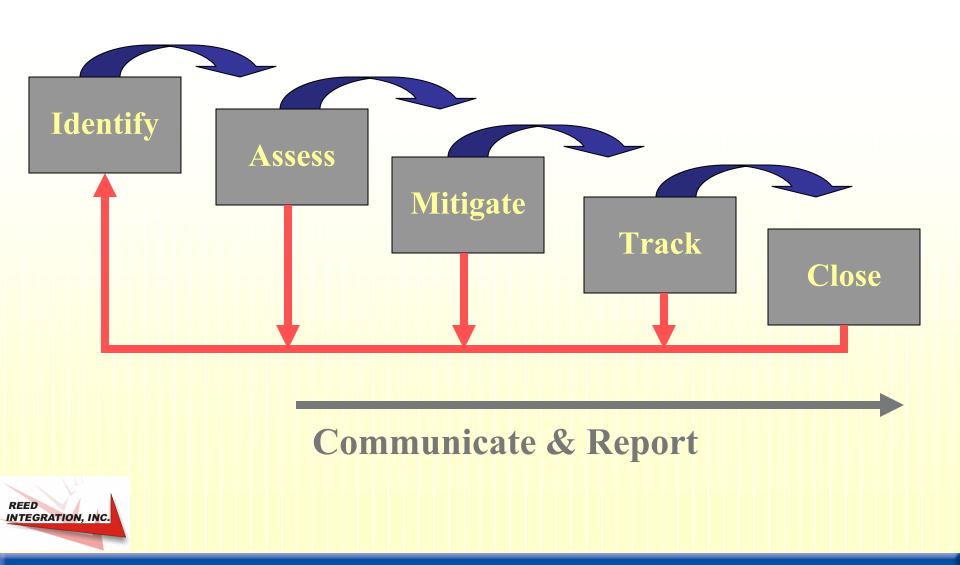
### Fundamental Principles of Risk

- •All programs have risk.
  - -Risk isn't *necessarily* bad with uncertainty comes opportunity
  - -The question is not: "Is there risk?"
  - -The question is: "Where is the risk, and how are you managing it?"
- Risk is relative to a plan or requirement
- Risk management is a continuous process
- •If you haven't identified the risk, you are already taking it
- To Succeed??? -- PLAN!

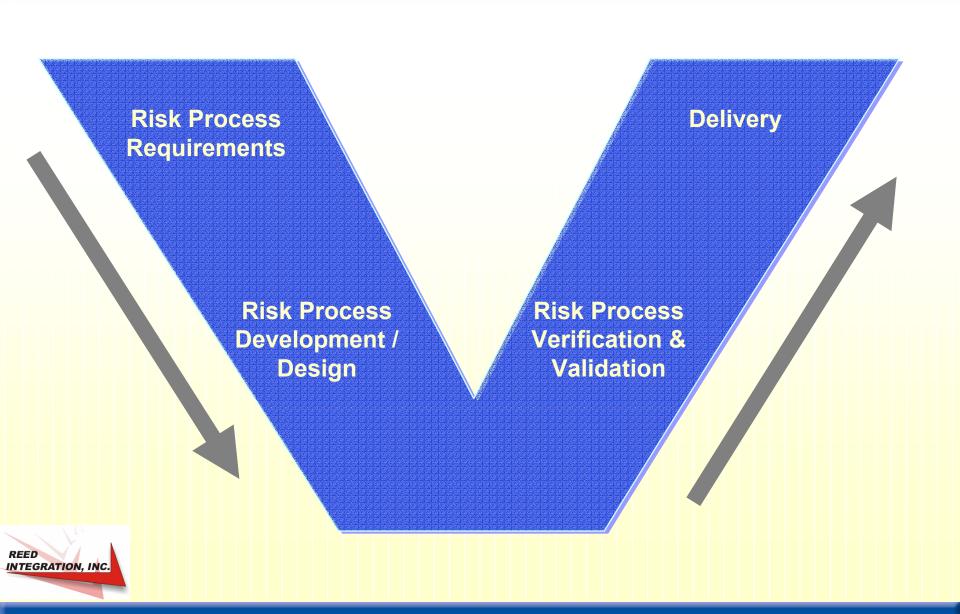
One of the nicest things about not planning is that failure comes as a complete surprise -Unknown



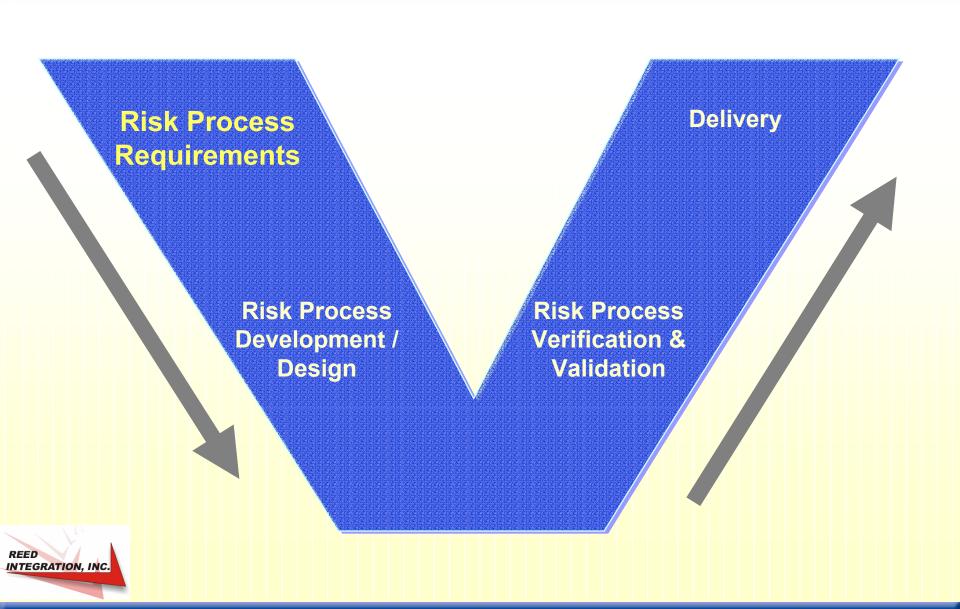
## Risk Management Process Steps



## **Approach**



## Requirements

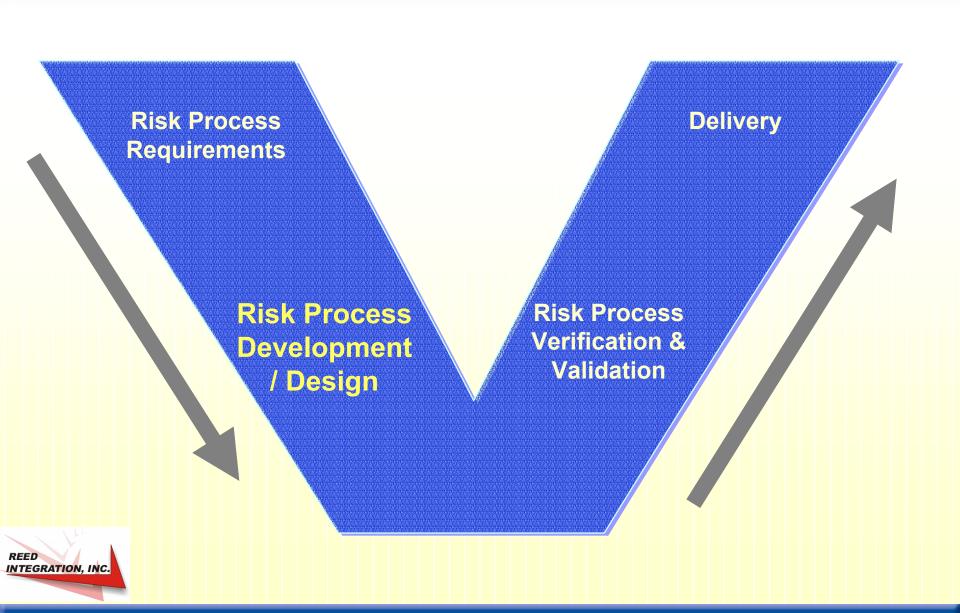


## Requirements

- Definition / Capture / Development
  - Customer Imposed
  - Program / Business Goals & Objectives
  - Resource Constraints
- Allocation
  - Key Participants
  - Authority / Signature



## **Development / Design**

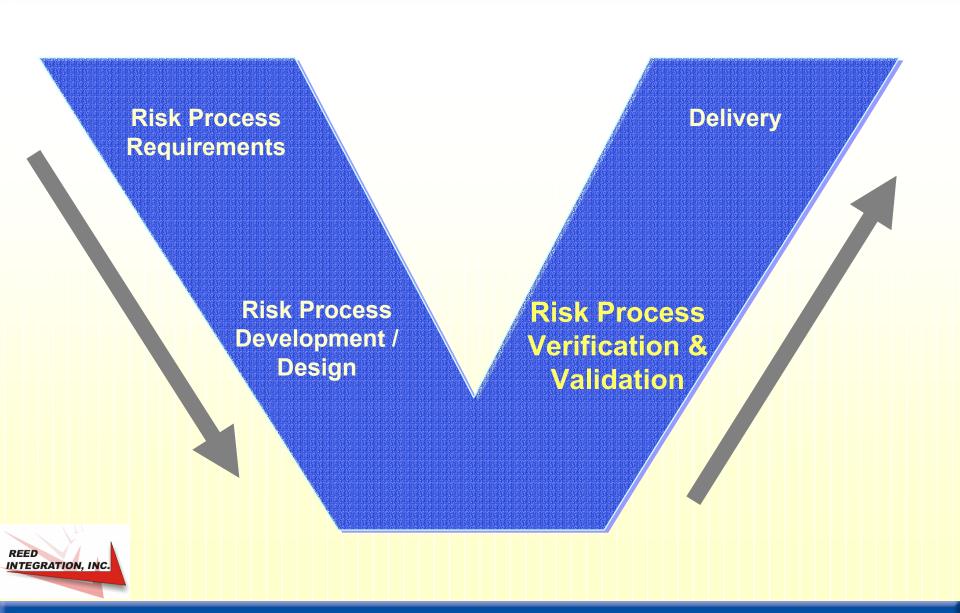


#### **Development / Design**

- Development / design process based upon requirements
  - Customer / Program imposed
- Interface definition
  - Ongoing project activities; EVM, TPM, IMS
  - Process step dependant
    - Example: Risk Identification safety analysis, testing, lessons learned, FMEA, etc.
- Assessment / criteria development
- Tracking / reporting methodologies



#### **Verification / Validation**



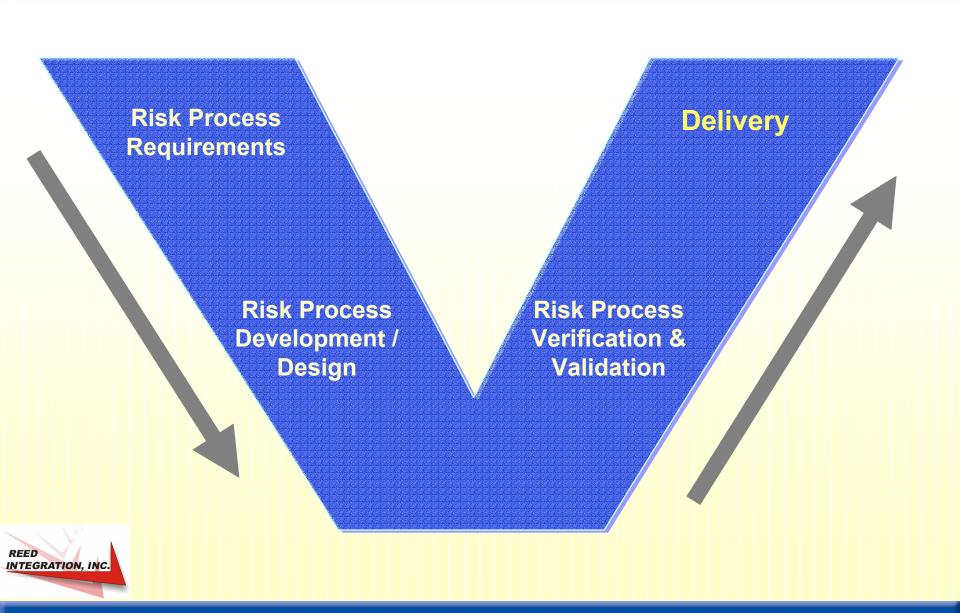
#### **Verification / Validation**

- Verify compliance of the process with requirements
  - Assessment methods, reports, signatures, etc.
- Validate performance / function of process
  - Comprehensive set of risks identified, assessed, managed, and tracked?
- Risk Verification Audit
  - A risk process self-assessment program in which managers assess quality of process performance
  - Evaluate the effectiveness of compensating controls

Conduct postmortems on losses to clearly establish the cause and corrective action, follow up with implementation

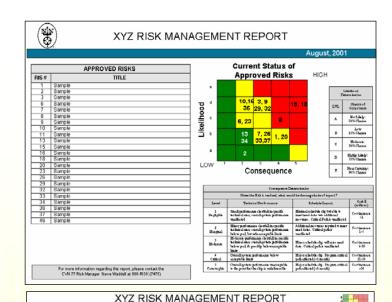


## Approach



#### **Delivery**

- Integrated risk report
  - Moderate / High level risks
  - Impact on interfacing activities
  - Output from interfacing activities
- Results from SE tools
  - Trade Studies, Plans, analyses



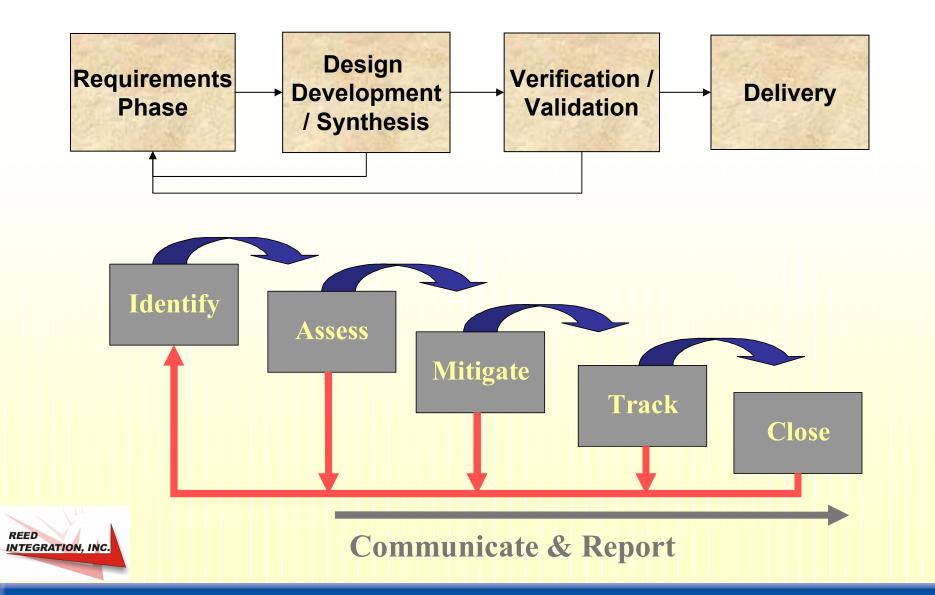
RIS ID#	Division	PWBS	Title and Risk Description	Risk Level	Current Progress	Mitigation Status*
23	Program Office	1.1.4	Title: Leck of an Weijl WLijily Description of Rick Condition. XYZ does not possess an integrated program schedule which elegands provides variability, consistency, and understooding of lay does and events critical to the XYZ Program. Consequence (Realized Lack of programs wheility recensusy to identify and advise overall schedule issues and delinquencies that impact on-time suggests completion.	Initial Mod D3 Prev Mod D3 Current Mod C2	Statust requirerasodniav/sodiisoali asodnisad saksiplaadid siidili saltik ikdif lasdidi lasdidi sadti iklaif ladidi lokif lasdidi sadti iladi ladidi lokif lasdidi sadti iladi disawoirwerjadfiladi filiq kij kij dif	□On track □ Off track □ Requires major charge
			Risk Lead: Jerry R James			
	Materiali & Manufart	1.1	Title XOUNIU und Schedule  Description of Kish Condition: The XOUIU Schedule developed in  November 2010 will not meet all delivery dates scheduled by the Program.  Consequence of Realized: Not completing XOUIU Units in time to rapport  the slap need date will impact joining and erection of the superlifts on the  final assembly pilets.  Risk Leads: Mark Scheder	Initial Mod D3 Prev Mod D3 Current Mod D3	Statust requirerascolysisticifyleadij audo Jusui abalyšisticifylidid odditja bloži lauditja leistifi, sakaj fleidrij bloži labadij Budrij albaj bij bij dasweinverjadillojad filoj bij bij di' dasweinverjadillojad filoj bij bij di'	On track Off track Requires major change
29	Non-Nuclear Engineering	2.4	Title Shock Qualification of Weiget X. Description of Rich Condition. Weiget X requires shock testing and qualifications have not been identified the amount of shock qualification and string for these components is unknown. Consequence if Residued: Increased costs due to redesign, rework, and shock tests we areast of an inaccurate BOE. Risk Lead: Terry Arche-	Initial High C4 Prev N/A Current Mod B4	Statust requireraschjawfedijkealij aedorjjaed achtjäbladdij dildrjedilitej Doği fanditëj hadig sadij slekji leksif ledistj lekji lekndij ledij alkoj itej ki deaweiuwerjedilitjed ilkej kij kij di	©Ou track ☐ Off track ☐ Requires major change
32	Program Office	245.1	Title XTV Availability Risk Conditions XTZ may not be available from the manufacturer in time for detailed design and construction. Risk Consequence: Lack of XTZ can create schedule problem for NNS and the LWP or cause a contly redesign to certain spaces.  Risk Lead. 4ef Statum	Initial Mod C3 Prev Mod B4 Current Mod B4	Risk level validated at B4 during "risk week" August 14. Raytheon current cost is estimate only.	⊠On track. ☐ Off track ☐ Requires major change







### **The Big Picture Summary**



# Integrated Approach Requires Understanding Stakeholder Objectives





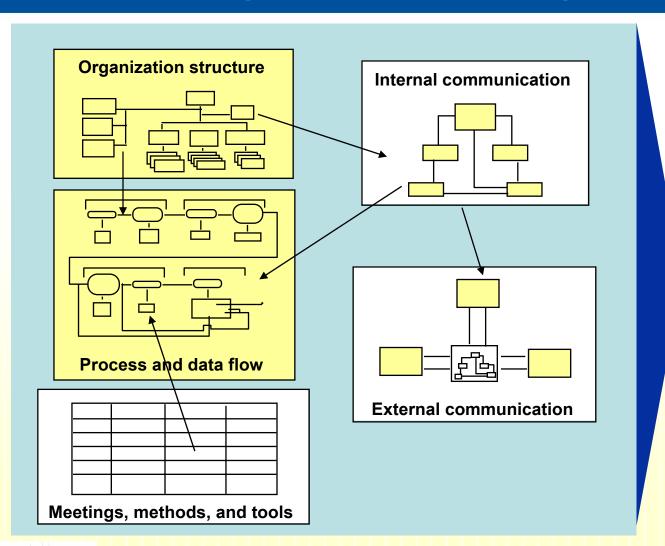
#### **Details**

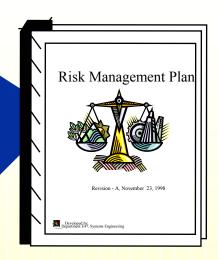
Implement SE methods and tools to ensure an integrated risk process:

- Plans
- Interface definition and control
- Studies
- Analyses



## **Risk Management Planning**







#### **Interface Definition**

- Define interfaces with other project activities / organizations
  - Cost Engineering
  - Insurance & Loss Control (Supplier Quality)
  - Safety
  - Design
  - Manufacturing
  - Etc.



#### **Interface Control**

#### Control defined interfaces

- Risk verification audit
  - Quality checklist
- Confirm interfacing organizations / activities are participating as needed



#### **SE Tool: Trade Studies**

High risk for adverse Program disruption and/or costs

Moderate risk for adverse Program impact

Minimum risk for adverse Program impact

OPTIONS		Option # 1	Option # 2	Option # 3	Option # 4	Option # 5		
					Alternate Supplier			
Evaluation Selection Criteria	Weight Factor	Significant Characteristics						
Performance	20%							
Schedule	30%							
Design/Construction	15%							
Material Availability	15%							
Cost	40%							
Non Recurring Engineering	10%							
Raw Material/Freight	10%							
Production	10%							
Other	10%							
Product Line Support	10%							
Product 1	5%							
Product 2	5%							
Weighted Total Score	100%	3.26	4.55	3.13	4.21	3.43		

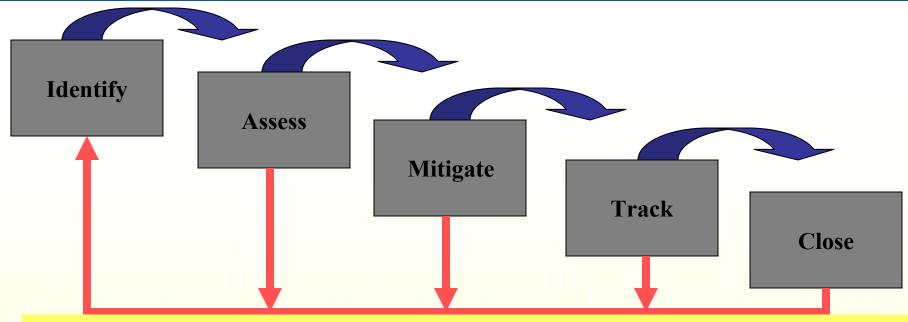
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#### **Analyzing the Risk Elements**

- Cost can we do it within the targets?
- Schedule can we deliver in time?
- Technology how mature is the technology?
- Requirements are they documented and stable?
- Engineering how much design effort required?
- Manufacturing can we produce it?
- Organization is it staffed, coordinated, controlled?
- Logistics can we support it?
- Capability do we have the skills and resources?



### Tools, Techniques and Interface Examples



- Expert Interviews Qualitative
- Brainstorming

- FMEA
- Lessons Learned
- Program Documentation
- TPM
- EVM
- Assumptions Analysis

- Request Add'l Funding
- Quantitative Implement Mgt Reserve Risk Attributes
  - Revise IMS
  - Alternate Supplier
  - Test
  - ROI

- Mitigation Status Report
- TPM
- SPI / CPI

- Mitigation Plan
   Reduced risk level
  - Assumption of risk
  - Program delivered
  - Lessons Learned



Communicate & Report

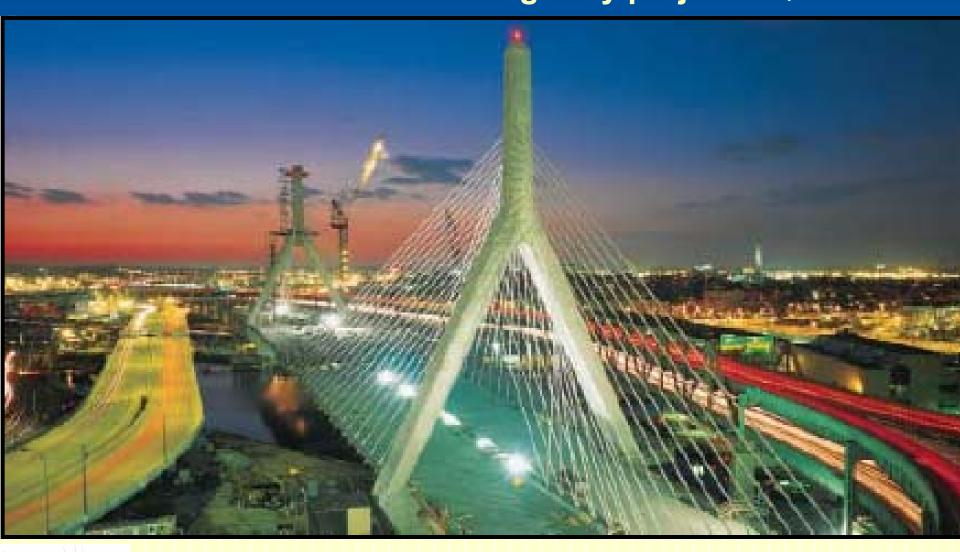
# Applying SE Approach Enhances Risk Management Effectiveness

### Effectiveness is determined by:

- How comprehensively and rigorously program
  - Explores for risk
  - Analyzes effects on program
- Level of Integration with Other Program Processes
- How disciplined the process is
- Validity of risk mitigation measures
  - Use of feedback mechanisms (TPMs, metrics)
  - Corrective action processes
- Timing

NTEGRATION, INC.

## Report: State was warned of \$14B Big Dig price tag; also estimates the final cost of the highway project at \$18 billion





#### Leonardo da Vinci

Study the science of art and the art of science.

Learn how to see and remember that

everything is connected to everything else.

Have we engaged the entire organization?



#### Reed Integration, Inc.

Reed Integration Is A Certified, Woman-Owned Small Business Focused on Comprehensive Systems Engineering Solutions and Training for a Diverse Client Base Including Government Defense and Civilian Agencies.

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